Pre-restoration study of the bottomland forest at the Olentangy River Wetland Research Park

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Introduction

Bottomland hardwood forests occur primarily on alluvial floodplain sites which are naturally extensive in areas where the soils are derived from poorly consolidated, sedimentary material which easily eroded. During geologic times, meandering stream currents across broad floodplains of the Mississippi drainage basin resulted in the formation of a diverse topography composed of natural levees, ridges, backwater areas and sloughs. More recently, floodplains have been deeply shaped and modified by various human activities (e.g., construction of artificial dams and levees, changes in the surrounding landscape, use of water for agriculture irrigation and water supply, etc.). These activities have resulted in significant changes including degradation of water quality, decreased water storage and conveyance capacity, loss of habitat for fish and wildlife, and decreased recreational and aesthetic values.

Given all theses changes, the potential for restoring the conditions in the US rivers and streams—and the systems connected to them—and protecting them from further damage is almost boundless. As part of a mitigation plan for the Spring-Sandusky Interchange in downtown Columbus (OH, USA), The Ohio State University, in cooperation with the Ohio Department of Transportation (ODOT), will restore a bottomland forest located at the Olentangy River Wetland Research Park along the Olentangy river. This restoration will be followed by a 5 years period of monitoring. The project will also allow a pre-implementation monitoring period followed by the 5-year post-restoration monitoring. The success of this restoration will be determined by comparing background data to post-restoration data on a number of biotic and abiotic factors. This paper represents early data collected in the bottomland forest during 1998, prior its restoration which is now expected to occur in 2000.

Methods

Hydrology

Twelve observation wells have been installed over the years in and around the bottomland forest (Fig. 1). Groundwater levels were recorded in these wells with a water level probe on an weekly basis from June to December 1998. At the same time, the Olentangy river level was recorder at the Clinton Park staff gage.

Water quality

Water samples were taken weekly over the six months period in each well and in the Olentangy River. A hand bailer was used to extract samples. Each wells was bailed for approximately 3 well volumes before the sample was taken. At the site, water quality was testing for pH, conductivity, dissolved oxygen, redox potential and temperature, using a YSI multiprobe. Nitrate-nitrogen, orthophosphate, and total dissolved phosphorus were measured in the lab using a Lachat QuickChem IV automated system and Lachat Methods.

Vegetation diversity

Vegetation was surveyed along 6 transversal (T1, T2, T3, T4, T5 and T6) and 2 longitudinal (TA and TB) transects (Figure 1). Sampling points for the tree survey were located every 10 m along the transversal transects and every 20 m along the longitudinal ones. Tree diversity was measured in August 1998 with the point quarter method at each sampling point. Herbaceous vegetation was surveyed in July/August 1998 in 4 m^2 quadrat placed every 10 m along the transversal transects. Total herbaceous vegetation cover and species cover were estimated at each quadrat. We used the Braun-Blanquet cover scale: (+) a few individual, vegetation cover < 5 %, (1) plentiful, vegetation cover < 5%, (2) vegetation cover between 5 and 25 %, (3) vegetation cover between 25 and 50 %, (4) vegetation cover between 50 and 75 %, and (5) vegetation cover > 75 % (Braun-Blanquet, 1932).

Litter Production

Litterfall was collected at 8 stations inside the bottomland forest (Fig. 1). At each station, 5 litter traps were randomly installed under the canopy. The litter was collected every other week, brought back to the laboratory, dried at 105°C, and weighted.

Soils

Soil samples were taken along each transversal transect at each sampling station location. Soil color, compared to a standard Munsell color chart, was checked to determine if hydric soils were present in the forest. Soil samples were collected in plastic bag and preserved at low temperature (below O°C) for future analyses.

Results and Discussion

Groundwater hydrology

River stage was low during the groundwater sampling period with only 3 high water events, one in late June, one in mid-November, and one in late December 1998. This survey demonstrated that in all wells the groundwater responded to precipitation: the peak of groundwater closed to the surface in late June was correlated to large amount of precipitation. We also demonstrated that some of the groundwater elevations responded to pumping into the 2 experimental wetlands located at the ORW (for details, see Micucci, 1999).

Sampling of groundwater elevations revealed that the groundwater was very close to the surface (between 0 and 75 cm down) in depressions of the bottomland forest (Wells M1 and M5) both during the dry and the floods events (Fig. 2). During non-flood events the groundwater was located between 90 and 150 cm below the ground. In all the other wells, the groundwater was much deeper with the deepest point at the south extremity of the forest (Well M7). For future research in the bottomland forest the setting in the ground of Wells M6, M7, M8 and M9 should to be checked.

Water Quality

All the raw data concerning nitrate, total soluble phosphorus, and orthophosphate concentration in the groundwater during the study period are presented in appendices A, B and C. Figure 3 represents the pattern of nitrate concentrations in the groundwater at three flood events: June 30, November 11 and December 15. During

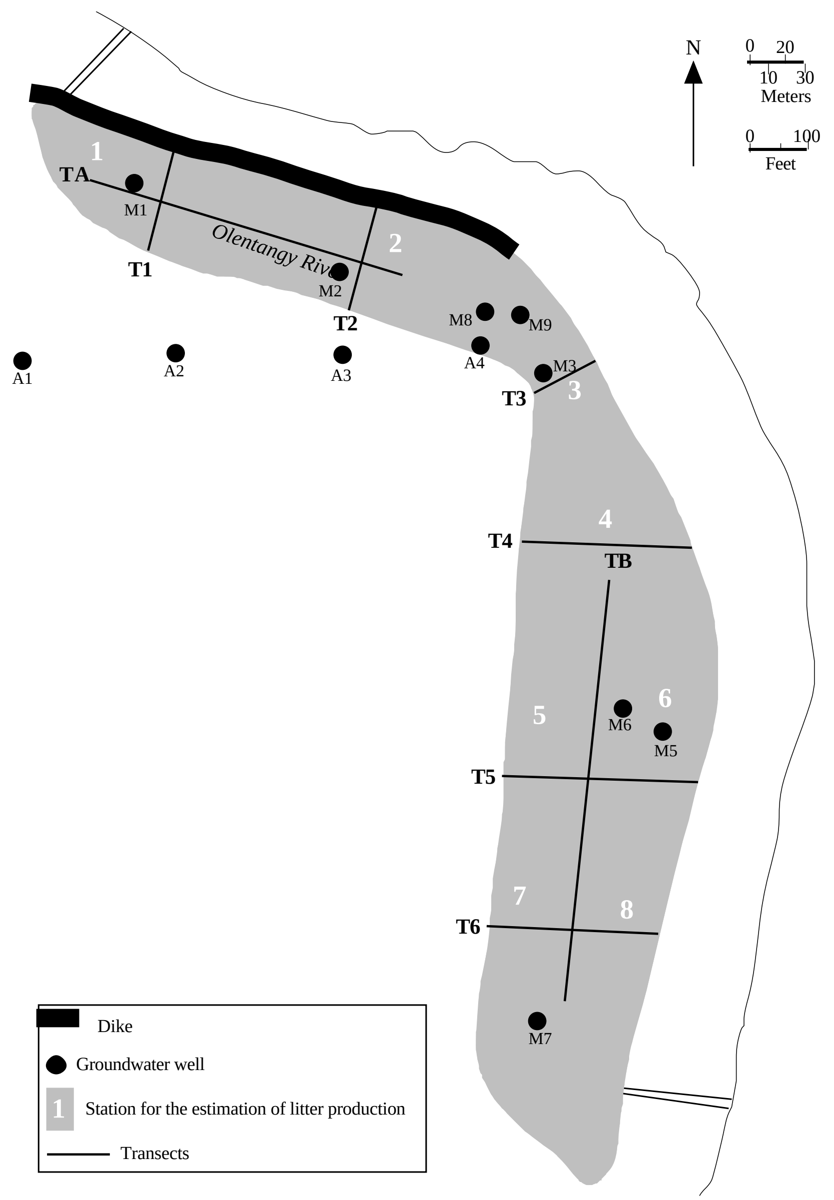

Figure 1. Map of the bottomland forest at the Olentangy River Wetland Research Park with indication of the vegetation transects and the groundwater wells.

these 3 floods, concentrations of nitrate in the Olentangy River were 5.90, 0.63 and 0.42 g-N/L, respectively. Therefore the first flood corresponded to a major input of nitrate to the system, compared to the two other floods. During June high water, nitrate concentrations were much lower in almost all bottomland wells (M1, M2, M3 and M5). Only Well M6 showed high concentrations of nitrate. We hypothesize that this particular well was not properly installed.

During the second flood event in November, high nitrate concentrations were observed in some of the bottomland wells (M2, M6 and M7), but still low concentration were in other wells located inside the bottomland (Wells M1 and M5). These last two wells are located where groundwater is very close to the surface.

Finally during the last flood (December), even though the nitrate concentrations in the surface water were low (0.42 g-N/L), we still observed high concentrations in Wells M6 and M7, and insignificant (below the level of detection) concentrations in all the other wells.

Concentration of dissolved oxygen in the groundwater followed the same pattern as nitrate, but was even more pronounced with the lowest concentrations measured in Wells 1 and 5 (Figure 4).

Vegetation

Results of the vegetation survey are presented in Appendices D (tree survey) and E (herbaceous survey). *Acer negundo* (FAC+), *Asimina triloba* (FACU+), *Aescules glabia* (FACU+) were the dominant species found in the bottomland and represented 23%, 16%, and 15% of the species counted, respectively. These data compare favorably

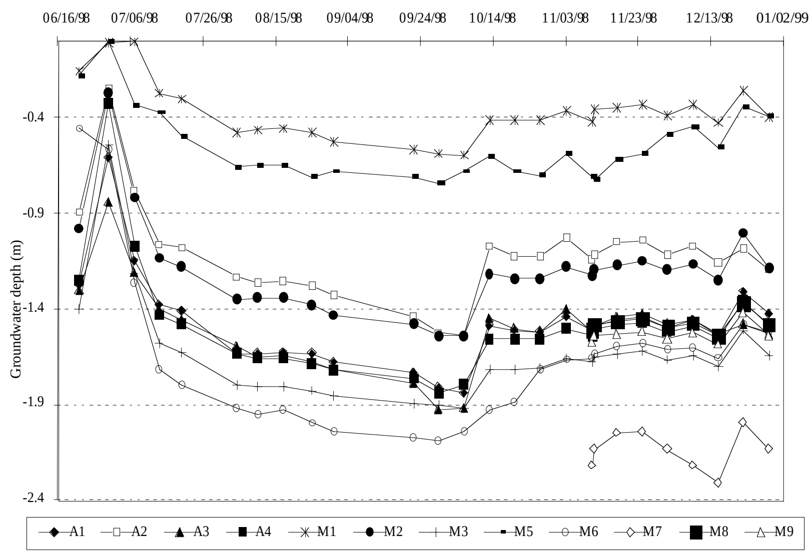

Figure 2. Groundwater depth (m) in the 12 wells located in and around the bottomland forest between June and December 1998

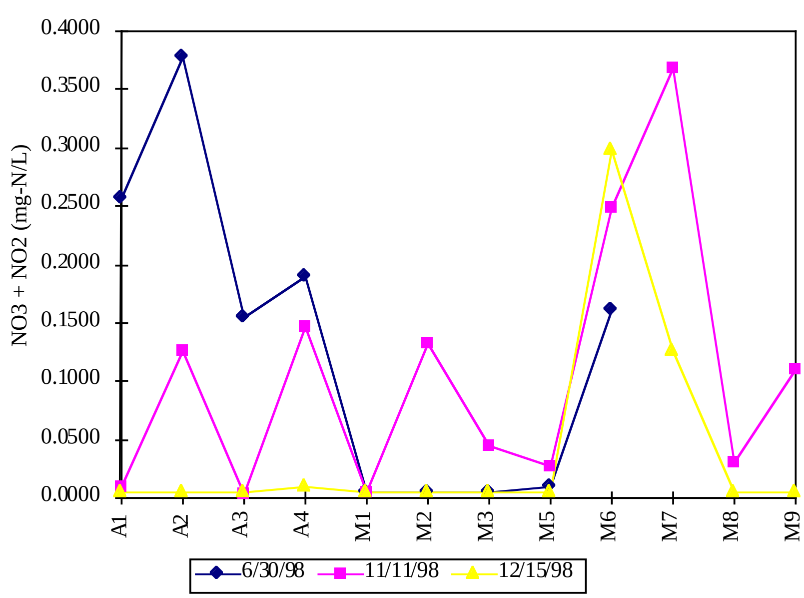

Figure 3. Concentration of nitrate in groundwater wells at three selected sampling dates

with previous studies at the site (Mitsch, 1992, Knorr, 1998), except for the higher dominance of *Asimina triloba* in our study. This difference may be due more to the use of different sampling points than to changes in the real tree composition. This present study represents the most intensive survey with a total of 45 points (28 in Mitsch, 1993; 25 in Knorr, 1998). Most of the herbaceous species are indicative of forest systems or open systems. Only a long-term survey of the vegetation will give us indication whether or not a community based on wetland species will develop in the future.

Litter production

The global litterfall production of the forest was 540±98 g m^{-2} (ave.±std dev), which is considerably higher that the value obtained by Harvan (1998). There were no significant differences of litter production among stations, even though some "wet" stations (Station 6 in particular) had a tendency to have higher production.

Soils

The majority soil samples collected in the bottomland were dark yellowish-brown to brown soil (Table 1). At most of the stations, there were no differences between the two layers. Under most conditions, a chroma less than 2 is considered to be indicative of hydric soils. For most of the transects, wetland soils were only found in quadrats close to the river. Only transect T1 had hydric soil in the first two quadrats (T1.1 and T1.2) and upland soil in the quadrat closest to the river (T1.3). T1.3 corresponds to the dike whereas T1.1 and T1.2 correspond to actual depressions were the groundwater is close to the surface.

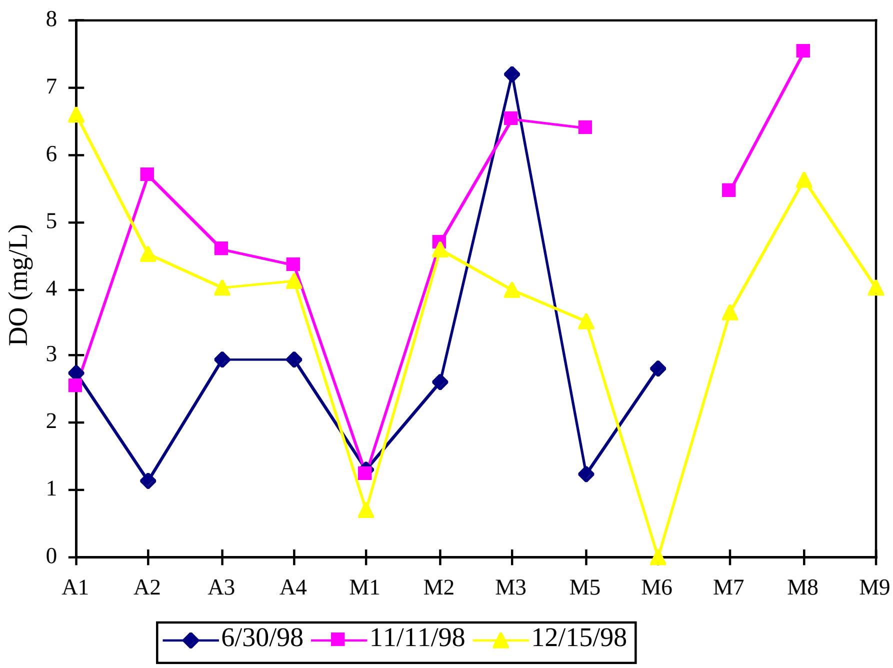

Figure 4. Concentration of dissolved oxygen in groundwater wells at three selected sampling dates

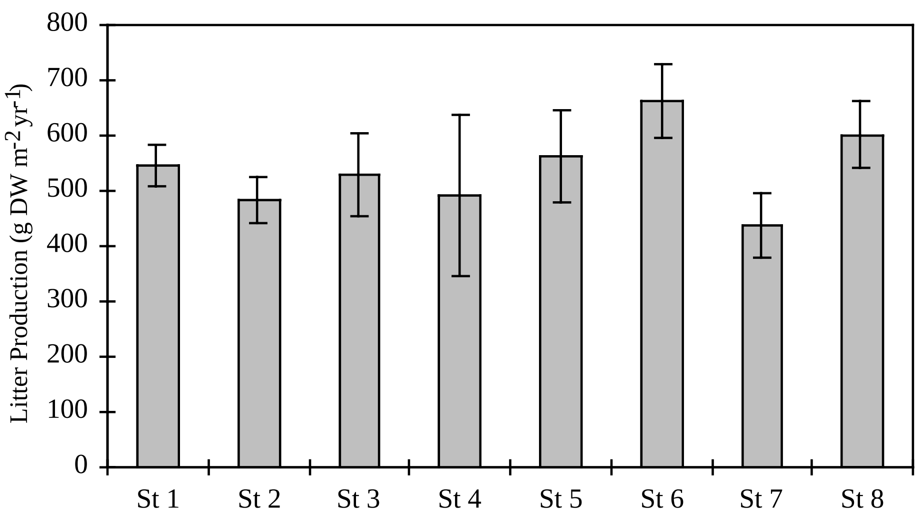

Figure 5. Litter production at the different sampling stations

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Acknowledgments

The help of Kelly Cornell was greatly appreciated during most of the study, both in the field and in the lab.

Table 1. Soil color (value-chroma) along the transect (1.1= transect 1, first quadrat; 1.2= transect 1, second quadrat, etc)

	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4	4.5	4.6
0-5 cm	4-2	3-2	3-3	4-4	3-4	3-3	3-2	4-3	3-3	4-4	3-2	3-3	4-2	3-2	3-3	3-2	3-2
5-10 cm	4-2	3-2	3-2	4-4	4-4	3-3	3-2	4-4	3-4	4-5	3-3	3-4	4-3	3-2	3-3	3-2	3-2

	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6
0-5 cm	4-3	4-3	3-3	3-2	3-2	4-3	4-3	4-3	3-2	3-2	3-2
5-10 cm	4-3	4-3	3-3	3-2	3-2	4-3	4-3	3-3	3-2	3-2	3-2

Appendix A. Nitrate concentration in groundwater wells from June, 22 to December, 29 1998.

	River	A1	A2	A3	A4	M1	M2	M3	M5	M6	M7	M8	M9
6/22/98	1.9863	0.1427	0.4221	0.3301	0.0974	0.0050	0.1697	0.0221	0.1021	0.0930			
6/30/98	5.9034	0.2569	0.3777	0.1551	0.1899	0.0050	0.0050	0.0050	0.0101	0.1606			
7/7/98	2.9143	0.1524	0.4821	0.2125	0.1212	0.0050	0.0050	0.0050	0.0897	0.1067			
7/14/98	1.7761	0.1021	0.2145	0.0050	0.0934	0.0170	0.0050	0.0478	0.0050	0.0050			
7/20/98	1.4125	0.0050	0.3900	0.0200	0.0205	0.0050	0.0050	0.0050	0.0050	0.0400			
8/4/98	1.2154	0.0500	0.1040	0.2000	0.2236	0.0050	0.0050	0.0100	0.0050	0.0200			
8/10/98	1.0456	0.0050	0.0050	0.0300	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050			
8/17/98	0.6852	0.0200	0.0050	0.0300	0.0050	0.0050	0.0050	0.0050	0.0050	0.0101			
8/25/98	0.7118	0.1183	0.1300	0.2538	0.0963	0.1481	0.1096	0.0412	0.0595	0.0236			
8/31/98	0.5856	0.1679	0.1511	0.0981	0.1578	0.1543	0.1511	0.2140	0.1116	0.1087			
9/22/98	0.5073	0.0050	0.1722	0.0412	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050			
9/29/98	0.5274	0.0050	0.0050	0.1215	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050			
10/6/98	0.9951	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050			
10/13/98	1.0421	0.1056	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050			
10/20/98	1.1823	0.1236	0.1456	0.0115	0.0050	0.0050	0.0050	0.0050	0.0362	0.0050			
10/27/98	1.1853	0.0118	0.1312	0.0658	0.0234	0.0050	0.1618	0.0150	0.0649	0.0305			
11/3/98	0.8341	0.0476	0.0122	0.0169	0.0298	0.0050	0.0050	0.0050	0.0050	0.1363			
11/10/98	1.1792	0.0309	0.0349	0.0193	0.0242	0.0050	0.0330	0.1601	0.0495	0.0359	0.2396		
11/11/98	0.6346	0.0102	0.1265	0.0026	0.1474	0.0050	0.1325	0.0441	0.0276	0.2486	0.3687	0.0305	0.1106
11/17/98	0.1820	0.1250	0.2024	0.2000	0.3110	0.2152	0.2021	0.0050	0.2021	0.2002	0.5024	0.2102	0.0050
11/24/98	0.1905	0.0298	0.2109	0.2000	0.2070	0.2015	0.2086	0.0050	0.1235	0.2108	0.5019	0.2005	0.0050
12/1/98	0.0707	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0285	0.0050	0.4723	0.4393	0.0050	0.0050
12/8/98	0.6883	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.2154	0.2272	0.0050	0.0050
12/15/98	0.4232	0.0050	0.0050	0.0050	0.0103	0.0050	0.0050	0.0050	0.0050	0.2987	0.1256	0.0050	0.0050
12/22/98	0.6320	0.0236	0.0895	0.1025	0.0698	0.0050	0.0050	0.0108	0.0050	0.5214	0.3256	0.0050	0.0050
12/29/98	0.1258	0.0365	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.2987	0.4125	0.0050	0.0050

Appendix B. Orthophosphate concentration in groundwater wells from June, 22 to December, 29 1998.

	River	A1	A2	A3	A4	M1	M2	M3	M5	M6	M7	M8	M9
6/22/98	0.0104	0.0128	0.0159	0.0164	0.005	0.005	0.005	0.005	0.0199	0.005			
6/30/98	0.0115	0.0174	0.0198	0.0179	0.005	0.005	0.0128	0.005	0.005	0.0169			
7/7/98	0.1104	0.0181	0.0457	0.0555	0.005	0.005	0.0123	0.0152	0.0102	0.0184			
7/14/98	0.1023	0.0123	0.0256	0.0325	0.0102	0.005	0.0125	0.005	0.005	0.0202			
7/20/98	0.0394	0.005	0.005	0.005	0.005	0.005	0.0126	0.005	0.005	0.0296			
8/4/98	0.1124	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.0103			
8/10/98	0.1161	0.005	0.018	0.005	0.005	0.005	0.005	0.005	0.005	0.005			
8/17/98	0.1256	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005			
8/25/98	0.1372	0.005	0.0063	0.014	0.005	0.005	0.005	0.005	0.005	0.005			
8/31/98	0.1087	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005			
9/22/98	0.1544	0.005	0.0194	0.0554	0.0431	0.005	0.005	0.005	0.005	0.005			
9/29/98	0.0922	0.0985	0.0117	0.36	0.0406	0.005	0.005	0.005	0.005	0.005			
10/6/98	0.1956	0.103	0.0392	0.0373	0.0291	0.005	0.005	0.0109	0.0109	0.005			
10/13/98	0.2241	0.005	0.01	0.005	0.005	0.005	0.005	0.0246	0.005	0.005			
10/20/98	0.2678	0.005	0.005	0.005	0.005	0.005	0.0216	0.005	0.005	0.005			
10/27/98	0.3193	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005			
11/3/98	0.2307	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005			
11/10/98	0.2319	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.013	0.0105	0.005	0.005	0.005
11/11/98	0.2411	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
11/17/98	0.0244	0.005	0.005	0.0176	0.005	0.0621	0.005	0.005	0.005	0.005	0.005	0.005	0.0556
11/24/98	0.042	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.0457	0.005	0.005	0.005
12/1/98	0.005	0.005	0.0156	0.005	0.005	0.005	0.0005	0.005	0.005	0.0262	0.005	0.005	0.005
12/8/98	0.1078	0.005	0.0109	0.005	0.005	0.005	0.0005	0.005	0.005	0.0165	0.005	0.005	0.005
12/15/98	0.1223	0.005	0.005	0.0109	0.012	0.005	0.0005	0.005	0.005	0.005	0.005	0.005	0.005
12/22/98	0.0005	0.1056	0.005	0.0102	0.01125	0.005	0.0005	0.005	0.005	0.0159	0.012	0.0108	0.0105
12/29/98	0.0158	0.005	0.0125	0.005	0.005	0.005	0.0005	0.005	0.005	0.005	0.005	0.005	0.005

Appendix C. Total dissolved phosphorus concentration in groundwater wells from June, 22 to December, 29 1998.

Date	River	A1	A2	A3	A4	M1	M2	M3	M5	M6	M7	M8	M9
6/22	0.097	0.021	0.040	0.022	0.020	0.004	0.039	0.099	0.067	0.049			
6/30	0.088	0.013	0.028	0.018	0.100	0.003	0.036	0.057	0.006	0.060			
7/7	0.092	0.025	0.022	0.002	0.014	0.004	0.010	0.011	0.013	0.041			
7/14	0.112	0.016	0.011	0.001	0.010	0.005	0.003	0.012	0.005	0.012			
7/20	0.122	0.016	0.010	0.016	0.004	0.002	0.004	0.026	0.003	0.010			
8/4	0.134	0.014	0.011	0.001	0.006	0.002	0.002	0.003	0.005	0.006			
8/10	0.138	0.085	0.080	0.001	0.009	0.004	0.011	0.012	0.022	0.010			
8/17	0.145	0.028	0.042	0.001	0.003	0.003	0.004	0.007	0.015	0.007			
8/25	0.152	0.002	0.059	0.001	0.005	0.005	0.000	0.004	0.028	0.011			
8/31	0.153	0.077	0.024	0.000	0.004	0.002	0.005	0.006	0.005	0.008			
9/22	0.207	0.088	0.027	0.066	0.007	0.003	0.002	0.003	0.004	0.012			
9/29	0.141	0.013	0.351	0.000	0.003	0.002	0.003	0.007	0.005	0.006			
10/6	0.254	0.094	0.100	0.027	0.027	0.012	0.012	0.010	0.006	0.009			
10/13	0.262	0.004	0.058	0.008	0.002	0.002	0.005	0.005	0.007	0.006			
10/20	0.307	0.020	0.001	0.006	0.009	0.002	0.006	0.013	0.006	0.006			
10/27	0.190	0.014	0.001	0.005	0.007	0.003	0.009	0.008	0.007	0.006			
11/3	0.272	0.005	0.007	0.006	0.006	0.006	0.005	0.012	0.006	0.008			
11/10	0.274	0.009	0.013	0.006	0.010	0.006	0.008	0.011	0.051	0.030	0.008	0.020	0.011
11/11	0.258	0.015	0.024	0.007	0.008	0.009	0.008	0.006	0.007	0.007	0.007	0.010	0.007
11/17	0.033	0.008	0.007	0.007	0.006	0.006	0.006	0.006	0.006	0.006	0.008	0.017	0.007
11/24	0.065	0.007	0.007	0.008	0.006	0.007	0.007	0.006	0.012	0.109	0.007	0.006	0.007
12/1/	0.065	0.007	0.011	0.007	0.010	0.006	0.007	0.007	0.006	0.009	0.008	0.008	0.008
12/8	0.158	0.009	0.009	0.009	0.008	0.008	0.008	0.007	0.008	0.010	0.008	0.007	0.006
12/15	0.264	0.070	0.013	0.049	0.007	0.006	0.007	0.010	0.007	0.007	0.010	0.009	0.009
12/22	0.215	0.126	0.011	0.058	0.021	0.020	0.010	0.006	0.005	0.010	0.572	0.010	0.024
12/29	0.329	0.099	0.055	0.007	0.007	0.008	0.007	0.006	0.006	0.006	0.006	0.011	0.011

Appendix D. Tree survey using the point quarter method at each quadrat of each transect (each transerval transect goes from the upland to the river with T11 = first quadrat of the first transect, T12 = second quadrat of the first transect, etc ; each longitudinal transect goes from north or north-east to south or south-west). Indication of distance(in meters) between the center of the quadrat and each tree.

	Species	Dist (m)
T-11	Acer negundo	8.10
	Populus deltoides	3.35
	Ulmus americanus	4.88
	Acer negundo	3.10
T-12	Acer negundo	2.39
	Carya sp.	7.25
	Acer negundo	2.82
	Acer negundo	5.13
T-13	Asimina triloba	1.07
	Asimina triloba	1.08
	Asimina tribola	0.95
	Asimina triloba	0.62
T-21	Cornus florida	9.60
	Morus rubra	6.60
	Acer saccharinum	2.43
	Juglan nigra	12.30
T-22	Ulmus america	7.72
	Cornus florida	6.21
	Ulmus rubra	1.10
	Juglan nigra	3.37
T-23	Asimina triloba	2.50
	Juglan nigra	2.98
	Acer negundo	2.72
	Sambuscus sp.	2.53
T-24	Asimina triloba	4.98
	Ulmus rubra	2.79
	Asimina triloba	2.10
	Asimina triloba	0.65
T-31	Acer negundo	7.47
	Morus rubra	8.12
	Morus rubra	2.01
	Cornus florida	4.32
T-32	Cornus florida	7.48
	Fraxinus quadrangul.	5.23
	Cornus florida	6.35
	Cornus florida	4.18
T-33	Acer negundo	3.20
	Fraxinus nigra	6.38
	Cornus florida	4.19
	Acer negundo	0.72
T-41	Populus deltoides	3.44
	Populus deltoides	2.13
	Populus deltoides	1.84
	Populus deltoides	1.92
T-42	Populus deltoides	3.47
	Catalpa speciosa	2.46
	Populus deltoides	0.36
	Platanus occidentalis	6.39
T-43	Acer negundo	2.39
	Acer negundo	0.47
	Morus rubra	2.14
	Morus rubra	1.07
T-44	Acer negundo	5.42
	Cornus florida	2.10
	Juglan nigra	5.25
	Juglan nigra	1.33
T-45	Asimina triloba	2.33
	Celtis occidentalis	1.55
	Asimina triloba	1.87
	Asimina triloba	1.09

	Species	Dist (m)
T-46	Celtis occidentalis	3.17
	Asimina triloba	5.21
	Asimina triloba	5.02
	Acer negundo	2.25
T-51	Juglan nigra	9.50
	Aescules glabia	2.70
	Maclura pomifera	2.27
	Aescules glabia	7.70
T-52	Acer negundo	5.61
	Celtis occidentalis	1.99
	Aescules glabia	4.85
	Juglan nigra	5.29
T-53	Aescules glabia	7.96
	Aescules glabia	7.56
	Aescules glabia	6.30
	Acer negundo	0.45
T-54	Platanus occidentalis	0.65
	Juglan nigra	1.04
	Aescules glabia	0.94
	Acer negundo	3.62
T-55	Robinia pseudoacacia	5.56
	Aescules glabia	1.87
	Celtis occidentalis	1.41
	Aescules glabia	1.94
T-56	Morus rubra	4.82
	Acer negundo	7.72
	Morus rubra	6.68
	Acer negundo	3.96
T-61	Celtis occidentalis	6.40
	Aescules glabra	2.34
	Maclura pomifera	2.20
	Acer negundo	1.75
T-62	Acer negundo	3.21
	Aescules glabra	6.47
	Aescules glabra	8.85
	Aescules glabra	1.24
T-63	Acer negundo	5.80
	Acer negundo	11.46
	Acer negundo	8.80
	Acer negundo	3.45
T-64	Acer negundo	6.55
	Juglan nigra	2.12
	Acer negundo	9.47
	Celtis occidentalis	1.33
T-65	Acer negundo	10.40
	Catalpa speciosa	3.78
	Salix nigra	6.12
	Acer negundo	2.81
Q-A1	Populus deltoides	3.69
	Acer saccharum	3.44
	Acer saccharum	4.21
	Acer saccharum	3.72
Q-A2	Acer negundo	2.23
	Acer negundo	4.20
	Ash sp	4.01
	Acer negundo	2.16
Q-A3	Celtis occidentalis	1.89
	Morus rubra	5.21
	Aescules glabra	3.08
	Morus rubra	0.23

	Species	Dist (m)
Q-A4	Asimina triloba	1.35
	Asimina triloba	1.83
	Asimina triloba	1.10
	Asimina triloba	0.65
Q-A5	Morus rubra	1.34
	Asimina triloba	2.04
	Populus deltoides	4.91
	Asimina triloba	4.33
Q-A6	Asimina triloba	1.23
	Asimina triloba	1.09
	Asimina triloba	1.43
	Platanus occidentalis	1.27
Q-A7	Aescules glabra	2.44
	Prunus serotina	6.04
	Morus rubra	0.61
	Asimina triloba	1.87
Q-A8 = Q 24		
Q-A9	Acer negundo	3.08
	Asimina triloba	2.32
	Asimina triloba	3.05
	Celtis occidentalis	4.02
Q-A10	Prunus sp	4.42
	Asimina triloba	1.10
	Asimina triloba	1.28
	Asimina triloba	1.55
Q-B1	Acer negundo	4.08
	Acer negundo	2.38
	Acer negundo	7.77
	Acer negundo	5.64
Q-B2 = Q-64		
Q-B3	Morus rubra	7.71
	Cornus florida	6.74
	Acer negundo	7.35
	Acer negundo	6.58
Q-B4	Cornus florida	0.46
	Aescules glabra	2.23
	Celtis occidentalis	3.78
	Celtis occidentalis	1.62
Q-B5	Celtis occidentalis	3.81
	Aescules glabra	4.79
	Morus rubra	5.39
	Morus rubra	2.80
Q-B6	Aescules glabra	5.64
	Aescules glabra	10.09
	Aescules glabra	3.78
	Aescules glabra	3.11
Q-B7	Aescules glabra	2.80
	Aescules glabra	3.69
	Aescules glabra	8.26
	Sugar maple	4.45
Q-B8	Celtis occidentalis	3.63
	Morus rubra	4.15
	Populus deltoides	3.90
	Acer negundo	7.25
Q-B9	Platanus occidentalis	4.97
	Populus deltoides	2.50
	Morus rubra	5.85
	Acer negundo	4.97
Q-B10	Celtis occidentalis	2.87
	Aescules glabra	2.32
	Aescules glabra	2.47
	Aescules glabra	4.33

Appendix E. Herbaceous vegetation survey in each quadrat along the transversal transects (1-1 to 1-3 : transect 1; 2-1 to 2-4: transect 2; etc) according to Braun-Blaunquet method.

	1-1	1-2	1-3	2-1	2-2	2-3	2-4	3-1	3-2	3-3	4-1	4-2	4-3	4-4	4-5	4-6	5-1	5-2	5-3	5-4	5-5	5-6	5-7	6-1	6-2	6-3	6-4	6-5	6-6	6-7
% cover	5	80	5	90	75	2	0	70	80	0	75	5	50	10	0	<1	5	5	80	2	10	5	10	5	0	80	80	< 2	20	< 2
Species																														
Alliaria petiolata					+																								1	
Amaranthus hybridus	+																													
Arundinaria gigantea																													1	
Asarum canadense																	2		3		+		+				1			
Aster vimineus	+	+									+	+														+				
Bidens frondosa									2																					
Cyperus esculentus											+																			
Daucus carota				+	+																									
Dicentra sp.										+				+				+												
Erigeron canadensis				+					+																					
Eupatorium rugosum			+						+			+	1	1					2		+					4	4			
Euphorbia sp.																			1											
Geum canadense																	1									3	3			
Glyceria sp.	+																											+		
Helenium nudiflorum					+																									
Lonicera maackii				5	1	+		2	2																					
Oxalis europaea													+																	
Phlox sp.																					+									
Phytolacca americana																								1						
Pilea pumila																						+							1	
Plantago major				+																										
Polygonatum biflorum		+																												
Polygonum hydropiper																							1					+		+
Polygonum pennsyl.																												+		
Polygonum persicaria	+																			+		+	2	+					1	
Rhus radicans		5	+		5			4			2		2								2									
Sanicula gregaria																+														
Sanicula trifolata			+											3		1														
Smilax rotundifolia								1	+												+									
Solidago bicolor					+																									
Solidago canadensis		+		+	+			2	+		2						+													
Sonchus oleraceus									+																					
Trifolium repens				+				+																						
Urtica dioica			+														+		3										1	
Vitis sp.									2		+								1											
Viola canadensis																														+
Viola sp.						+											+	+								1	2	+	1	1